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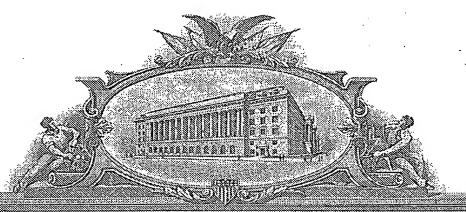
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**APPLICATION NUMBER: 60/536,731** 

FILING DATE: January 16, 2004 RELATED PCT APPLICATION NUMBER: PCT/US05/01254

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### PROVISIONAL APPLICATION FOR PATENT COVER SHEET

Ē	This a request for filing a PROVISIO	NAL APPLICATION F	OR PATENT un	der 37 CFR 1.53	(b)(2).	0 1
			)/APPLICANT(s)			U.S. 673
	C/Eiven Name (first and middle [if any])	Family Name or			Residenc	SE COUNTRIES O
	Ramal ·	SHAH .		1738 Carriage Sugar Land, T		<u>8</u> .
	Additional inventors are being na	amed on the sepa	rately numbered	sheets attached	hereto.	
		TITLE OF THE INVE	NTION (280 charac	ters max)		
	LPG/NGL (C2+) RECOVERY PROC	ESS FROM LNG - G	AS CONDITION	ING PROCESS		
		CORRESPOND	ENCE ADDRES	is		
	X Customer Number: 6449					
	Firm or Individual Name	Rothwell, Figg, Erns	t & Manbeck, P.0	<b>c</b> .		
	Address	1425 K Street, N.W.			·	
	Address	Suite 800		- · · · · · · · · · · · · · · · · · · ·		
	City	Washington	State	D.C.	ZIP	20005
	Country	U.S.A.	Telephone	202-783-6040	Fax	202-783-6031
,	ENC	CLOSED APPLICATION	ON PARTS (check	k all that apply)		
<b>}</b>		Sheets [ ]		nber		
	METHOD OF PAYMENT OF FIL	ING FEES FOR THIS	PROVISIONAL	APPLICATION F	OR PAT	ENT (check one)
	Applicant claims small entity:  A check or money order is en  The Commissioner is hereby or credit any overpayment to Payment by credit card. Forn	closed to cover the fili authorized to charge f Deposit Account Num	ng fee îling fees ber: <u>02-2135</u>	Filing Fee \$160.00	Amount:	•
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	Yes, the name of the U.S. Governme	ent agency and the Gove	ernment contract n	umber are:		
	Respectfully submitted,	•				
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### LPG/NGL (C2+) Recov ry Pr c ss from LNG - Gas Conditioning Process

### Prior rec rds of related reference Patent and Literature:

### Related Patents

- 1 Patent Number 2,952,984 (September 20, 1960) Processing Liquefied Natural Gas, Walton H. Marshall, Jr., Downings, Va., assignor, by mesne assignments, to Conch International Methane Limited, a corporation of the Bahamas. A process for efficiently separating methane from a liquefied gas with a minimum of equipment and cost.
- Patent Number 3,837,172 (September 24, 1974) Processing Liquefied Natural Gas To Deliver Methane – Enriched Gas At High Pressure, Inventors Stephen J. Markbreiter and Edison Irving Weiss, Brooklyn, N.Y., Assignee –Synergistic Services Inc., New York, N.Y. A process for separating ethane and heavier hydrocarbons from liquefied natural gas (LNG) to yield methane-enriched gas of predetermined heating value.
- 3. Patent Number 5,114,451 (May 19, 1992) Liquefied Natural Gas Processing, Inventors C.L. Rombo, John D. Wilkinson and Hank M. Hudson of Midland, Texas, assignee Elcor Corporation, Dallas, Texas. A process for recovery of ethane, ethylene, propane, propylene and heavier from a liquefied natural gas (LNG) stream.

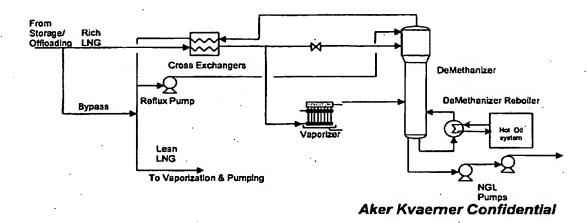
### Related Publications

- 4. "A Cost Effective Design For Reducing C<sub>2</sub> and C<sub>3</sub> at LNG receiving Terminals, by C.C. Yang, A. Kaplan and Z. Huang of Foster Wheeler USA Corporation, 2020 Dairy Ashford Road, Houston, Texas 77077. Published at AIChE and Oil & Gas Journal. (May have been applied for patent application). A cost effective method described involve a small amount of additional facilities not normally existing at receiving terminals to reduce C<sub>2</sub> and C<sub>3</sub> content to meet export gas at LNG terminals.
- 5. Gas Conditioning for Imported LNG, by Dan McCartney, Black and Veatch Pritchard, Inc. Overland Park, Kansas, U.S.A. Published at 82<sup>nd</sup> Annual Convention, Gas Processors Association, San Antonio, Texas. An energy efficient process for BTU control to high ethane recovery requiring very little incremental energy when compared to typical requirements.

### Aker Kvaerner Developed Process

The process developed by Aker Kvaerner is described below. Various alternative methods have been investigated. The new process is highly energy efficient, economical and can be integrated easily with traditional LNG terminal. It is designed to easily integrate in the LNG terminal to recover desired level of ethane, propane and heavier hydrocarbons to meet the desired export gas BTU requirements. The process is designed for high ethane recovery or very low ethane recovery while maintaining high propane plus recovery from LNG to meet export gas BTU requirements. It utilizes traditional vaporizers for heating requirements. No compression is required making it ideal for LNG Terminal application. A detailed process description and claims are to be developed. See a list of suggested claims at the end of the description.

### LPG/NGL Recovery from LNG - Gas Conditioning Unit



LNG (rich LNG) as received is a mixture of methane, ethane, propane, and heavier components. The rich LNG enters the unit at approximately -250F. This mixture is mostly methane but has a Gross Heating Value (GHV) which exceeds the sales gas specification. Therefore, some of the ethane plus heavier compounds must the removed from the rich LNG. These heavier compounds are removed in the Gas Conditioning Unit.

The Gas Conditioning Unit is a fractionation or distillation unit which fractionates propane and heavier compounds and recovers a large portion of the ethane contained in the rich LNG.

The Gas Conditioning Unit as shown above contains cross exchangers, a vaporizer, a Demethanizer (distillation column), a reboiler, and pumps. The Demethanizer has three feed streams and two product streams. The top feed stream is the columns' reflux stream and is all liquid. The middle feed stream is the column's primary feed stream and is all liquid. The bottom feed stream is column's secondary feed stream and is preheated. The top product stream is all vapor and mostly methane. The bottom product stream is a mixture of ethane and heavier compounds (NGL) fractionated from the rich LNG.

Rich LNG from storage is pumped through the cross exchangers and split into two streams. The top stream (primary column feed) enters the column at -129F. The other stream (secondary column feed) is heated to 40F using vaporizer and enters the Demethanizer about half way down the column. The vaporizer's heat source is sea water.

The cross exchangers condense the DeMethanizer's overhead stream (lean LNG) and preheats the rich LNG going to the Demethanizer which reduces column reboiler duty (i.e. Hot Oil System capacity) and Vaporizer heat duty. Part of the lean LNG stream at -141F is returned to the top of the Demethanizer as reflux increasing propane recovery while reducing the ethane removed. The remaining lean LNG then mixes with the rich LNG bypassing the Gas Conditioning Unit and the combined stream flows to pumping and Vaporization.

The Demethanizer is a trayed column utilizing approximately 30 trays. The Demethanizer fractionates the ethane, propane and heavier components from the methane and lighter components in the rich LNG. The lean overhead vapor stream containing mostly methane exits the Demethanizer at -121F. The bottom product stream mostly containing ethane, propane and heavier components exit the column at 96F. The bottom product is controlled by heat input to the reboiler to meet Y-grade methane specifications.

The NGL from the Demethanizer is pumped to NGL pipeline pressure and enters the NGL pipeline. Two pumps in series are used (one booster and one high pressure pump) since the NGL is at its boiling point when leaving the Demethanizer. The first pump provides the NPSH required by the high pressure pump.

### Suggested List of claims:

- Efficient and economical process for separating ethane, propane and heavier hydrocarbons from the LNG to meet export gas BTU requirements.
- 2. Utilizes sub-cooling (refrigeration) available from LNG to condense high pressure methane rich stream from a very high pressure demethanizer operations requiring lower level refrigeration as well as lower latent heat requirements to condense.
- Process can operate in high ethane recovery or ethane rejection (very low ethane recovery) mode while maintaining high propane and heavier hydrocarbons recovery from LNG.
- 4. Highly efficient process No compression is utilized for high pressure gas delivery.
- 5. Majority of heating requirements in the process is achieved by utilizing traditional vaporization equipment at the terminals i.e. Over the Rack Vaporizers (ORV) or Submerged Combustion Vaporizers (SCV) normally utilized at the LNG terminal.
- Reboller heating for the demethanizer can be supplied with Submerged Combustion Vaporizer providing safe method for heat supply (when waste heat is not available). Special design for utilizing SCV's in this service.
- 7. There are three version of the process. One process utilizes internal condenser (dephlamator).

C<sub>2</sub> Plus Recovery at LNG

**Gasification Terminals** 

Process designed to provide flexibility to recover NGL from LNG Ideal for C₂ plus recovery (mixed NGL) from LNG

Similar type of equipment utilized

➤ Very little learning curve for operators

Aker Kvaerner

## C<sub>2</sub> Plus Recovery at LNG Gasification Terminals

➤ Fuel efficient process

➤ Can be operated in either mode (LNG gasification or NGL recovery) Can be easily switched from one mode of operation to the other

➤ Economical

➤ Ideal process if NGL pipeline located in the vicinity of the terminal

Aker Kvaerner

# Data Required for Economic Model

▶ Gas composition

➤ Gas value \$/MMBTO

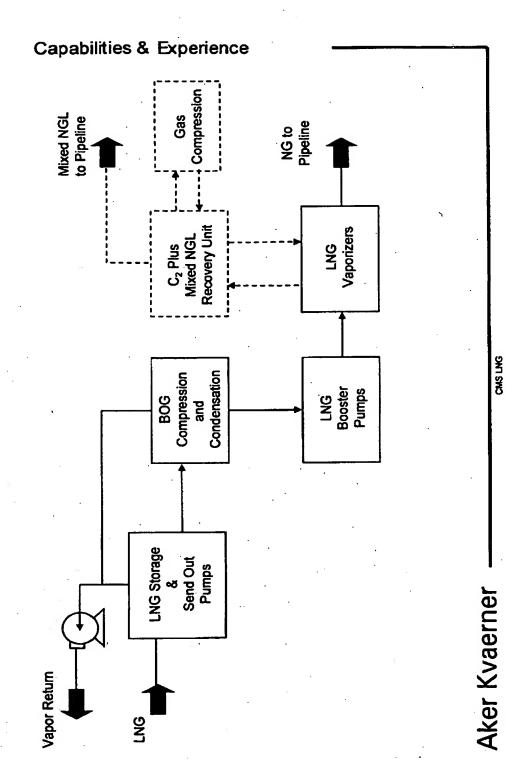
 $\triangleright$  C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub> and C<sub>5</sub>'s market value \$/gal

Electrical cost (if available)

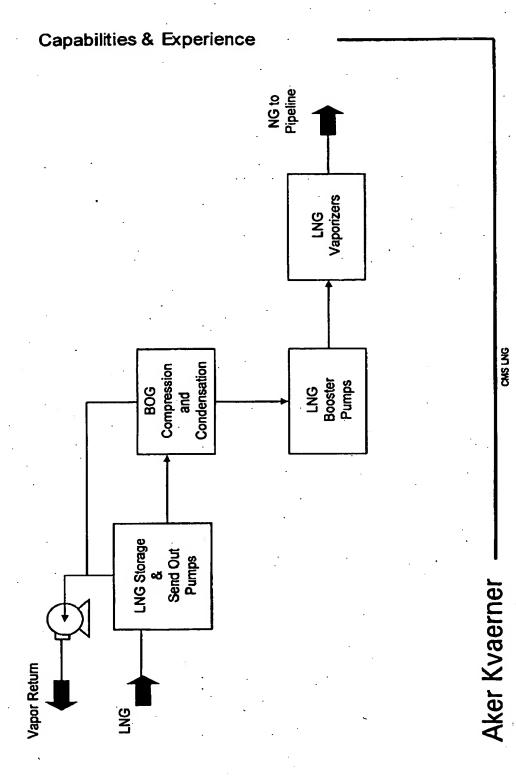
Any transportation cost (if pipeline transport) \$/gal

### LNG Vaporization with NGL Recovery

LNG



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17843450   8795   77271348   9841   50.81   7.827   7.827   1.865     7787.74   8.85   1920.28   1.39   6.26746   71.21   1.523.43   36.245     1786.34   2.17   10.72   0.01   1776.22   20.18   444750   10.889     4   279-88   0.34   0.56   0.00   27942   3.17   83.062   1.978     4   11.74   0.50   0.00   0.00   0.00   0.00   0.00   0.00     5   16.77   0.02   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00	7247450 8795 7727348 9844 50.82 0.58 7,221,43 36,245  727774 8.85 1020.28 1.39 626746 71.21 1,523,443 36,245  1765.94 2.17 10.72 0.01 1776.22 20.18 444750 10,889  4 279.98 0.34 0.56 0.00 27942 3.17 83,062 1,978  5 16.47 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.0	H <sub>2</sub> S	000	0.0	0.00	0.00	0.00	0.00	:	i		
1785.74   8.85   1020.28   1.39   6267.46   71.21   1.523.143   36,265     1786.54   2.17   10.72   0.01   1776.22   20.18   444,750   10,589     1786.54   2.17   10.72   0.01   1776.22   20.18   444,750   10,589     4   411.74   0.50   0.44   0.00   0.44   0.45   11,7842   1,578     5   16.47   0.02   0.04   0.00   0.00   0.00   0.00   0.00     5   16.47   0.02   0.00   0.00   0.00   0.00   0.00   0.00     10   10   10   10   10   10   10	1787.74   8.85   1920.28   1.39   6267.46   71.21   1,521.343   36,265     1786.34   2.17   10.72   0.01   1776.22   20.18   444/750   10,589     1786.34   2.17   10.72   0.01   1776.22   20.18   444/750   10,589     18.24   10.40   0.00   0.00   0.00   0.00   0.00   0.00     18.347.36   100.40   73545.65   100.00   8801.71   100.00   2,182,097   51,955     10.24   3.23   16.27   1018.86     10.24   1127.67   1018.86     11.27.67   1018.86     11.27.67   1018.86     11.28   14.596 Pela, @ 60 deg. F.	ູ້ບັ	72424.50	87.95	72373.68	98.41	50.82	0.58	7,827	981	•	
1786.54   2.17   10.72   0.01   1776.22   20.18   444,750   10,589     4   2179.58   0.24   0.25   0.00   2794.2   3.17   83,062   1,978     4   11.74   0.50   0.41   0.00   411.33   4.57   117840   2,806     5   16.47   0.02   0.00   0.00   0.00   0.00   0.00   0.00     5   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00     10   0.00   0.00   0.00   0.00     10   0.00   0.00   0.00     10   0.00   0.00   0.00     10   0.00   0.00   0.00     10   0.00   0.00   0.00     10   0.00   0.00   0.00     10   0.00   0.00   0.00     10   0.00   0.00   0.00     10   0.00   0.00   0.00     10   0.00   0.00     10   0.00   0.00   0.00     10   0.00   0.00     10   0.00   0.00     10   0.00   0.00     10   0.00   0.00     10   0.00   0.00     10   0.00   0.00     10   0.00   0.00     10   0.00   0.00     10   0.00   0.00     10   0.00   0.00     10   0.00   0.00     10   0.00     10   0.00   0.00     10   0.00     10   0.00     10   0.00	1786.94   2.17   10.72   0.01   1776.22   20.18   444/750   10,589     1786.94   2.17   10.72   0.01   1776.22   20.18   444/750   10,589     18.47   0.50   0.41   0.00   411.33   4.57   1178.40   2,806     18.47   0.02   0.00   0.00   0.00   0.00   0.00   0.00     18.48   0.00   0.00   0.00   0.00   0.00   0.00   0.00     18.59   0.00   0.00   0.00   0.00   0.00   0.00   0.00     18.59   0.00   0.00   0.00   0.00   0.00   0.00   0.00     18.59   0.00   0.00   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     18.50   0.00   0.00   0.00   0.00     19.50   0.00   0.00   0.00   0.00     19.50   0.00   0.00   0.00     19.50   0.00   0.00   0.00     19.50   0.00   0.00   0.00     19.50   0.00   0.00   0.00     19.50   0.00   0.00   0.00     19.50   0.00   0.00   0.00     19.50   0.00   0.00   0.00     19.50   0.00   0.00   0.00     19.50	ບົ	7287.74	8.85	1020.28	139	6267.46	71.21	1,523,143			
4 11.74 0.56 0.00 279.42 3.17 81362 1.978 4 141.74 0.50 0.41 0.00 411.33 4.67 117840 2.806 5 16.47 0.02 0.00 0.00 16.47 0.19 5.476 1.30 1.30 5 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	4 11.74 0.56 0.40 279.42 3.17 83.062 1,978 4 141.74 0.50 0.41 0.00 411.33 4.67 117,840 2,806 5 16.47 0.52 0.00 0.00 16.47 0.19 5,476 130 130 5 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	ິບ	1786.94	2.17	10.72	0.01	1776.22	20.18	444,750			
4 411.74 0.50 0.41 0.00 411.33 4.67 117,840 2,806  5 16.47 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.0	4 11.74 0.50 0.41 0.00 411.33 4.57 117,840 2,806  5 16.47 0.02 0.00 0.00 0.00 0.00 0.00 0.00 0.0	<b>'</b> '	279.98	0.34	950	0.00	279.42	3.17	83,062	1,978		
1647   0.02   0.00   0.00   16.47   0.19   5,476   130   15.40   0.00	s   1647   0.02   0.00   0.00   1647   0.19   5476   130   s   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00   lus   0.00   0.00   0.00   0.00   0.00   0.00   0.00   0.00   lus   0.00   0.00   0.00   0.00   0.00   0.00   0.00   lus   0.00   0.00   0.00   0.00   0.00   0.00   0.00   lus   0.00   0.00   0.00   0.00   0.00   lus   0.00   0.00   0.00   0.00   0.00   lus   0.00	P-C*	411.74	0.50	0.41	0.00	411.33	4.67	117,840			
10   10   10   10   10   10   10   10	s 6.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	ڹ	16.47	0.02	000	0.00	16.47	0.19	5,476			
0.00   0.00	0.00   0.00	2-a	0.00	00.0	0.00	0.00	9.0	0.00			100.00	
AL 82347.36 100.00 0.00 0.00 0.00 0.00 0.00 0.00 0	AL 82347.36 100.00 73545.65 100.00 8801.71 100.00 2,182,097 51,955  AL 82347.36 100.00 73545.65 100.00 8801.71 100.00 2,182,097 51,955  COLUME:  AY Total  COLUME:  C	ບ້	0.00	0.00	0.00	0.00	0.00	0.00	•	0	100.00	
AL 82347.36 100.00 73545.65 100.00 8801.71 100.00 2,182,097  (OLUME:	AL 82347.36 100.00 73545.65 100.00 8801.71 100.00 2,182,097  YOLUME:  YOLUME:  YOLUME:  C2+ 3.23	C, Plus	0.00	0.00	0.00	0.00	0.00	9.0		0	100.00	
FD 750.00 669.84 WT. 18.28 16.27 SCF: C2+ 3.23 C3+ 0.87 tal/scf 1019.30 917.74 ttul/scf 1127.67 1018.86  D VOLUME: AY Total G.@ 60 F d Conditions: 14.696 Psia, @ 60 deg. F.	FD   750.00   669.84   16.27   18.28   16.27   16.27   16.27   16.27   16.27   16.27   10.87   10.87   10.836   11.27.67   10.18.86   11.27.67   10.18.86   11.27.67   10.18.86   11.27.67   11.27.67   10.18.86   11.27.67   11.27.6	TOTAL	82347.36	100.00	73545.65	100.00	8801.71	100.00	2,182,097	51,955		
FD 750.00 669.84  WT. 18.28 16.27  SCF: C2+ 3.23  C3+ 0.87  tu/sef 1019.30 917.74  tu/sef 1127.67  D VOLUME:  AY Total  G. & 60 F  d Conditions: 14.696 Psia, @ 60 deg. F.	FD 750,00 669.84  WT. 18.28 16.27  SCF: C2+ 3.23  C3+ 0.87  (u/set 1019.30 917.74  tu/set 1127.67  D VOLUME:  AY Total  C. 26 60 F  14.696 Psia, @ 60 deg. F.	GAS VOLUME	**									
WT. 1828 1627  SCF: C2+ 3.23	WT. 1828 1627  SCF: C2+ 3.23  C3+ 0.87  (a)/sef 1019.30 917.74  tu/sef 1127.67  D VOLUME:  AY Total  C. @ 60 F  C. Conditions: 14.696 Psia, @ 60 deg. F.	MMSCFD		750.00		669.84						
SCF: C2+ 3.23 C3+ 0.87 C3+ 0.87 C3+ 1019.30 917.74  ttu/scf 1127.67 1018.86  D VOLUME: AY Total C.G. 60 F C. Conditions: 14.696 Psia, @ 60 deg. F.	SCF: C2+ 3.23 C3+ 0.87 C3+ 0.87 C3+ 0.87 C3+ 0.87 C3+ 0.87 C3+ 0.87 C4/Scf 1127.67 C5-@ 60 F C5-@ 60 F C6-@ 60 F C7- Conditions: 14.696 Psia, @ 60 deg. F.	MOL.WT.		18.28		16.27			ı		•	
C3+ 0.87 —— (2)+ 0.87 —— (2)+ 0.87 —— (2)	C3+ 0.87	GAL/MSCF:	\$	3.23		i						
b Volume:  AY Total G. & 60 R.	tu/sef 1019.30 917.74 tu/sef 1127.67 1018.86  D VOLUME:  AY Total — — — — — — — — — — — — — — — — — — —		\$	0.87		i						
D VOLUME:  AY Total  C. C. 60 F.  C. C. and ditions: 14.696 Psia, G 60 deg. F.	b VOLUME: AY Total C. @ 60 F. C. c. do G. f. f. 696 Psia, @ 60 deg. F.	LHV, Bw/scf	•	1019.30		917.74						
D VOLUME:  AY Total  .G. @ 60 F  d Conditions: 14.696 Psia, @ 60 deg. F.	D VOLUME:  AY Total  C. 26 60 F  d Conditions: 14.696 Psia, @ 60 deg. R.	GHV, Btu/scf		1127.67		1018.86	•		•			
AY Total	AY Total	רוסתום אסרת	JME:				· .					
.C. 66 60 K	.G.@ 60 F	BBL/DAY Total		1	•	ì			51,955	•		
d Conditions:	d Conditions:	NGT -S.G.@ 60	<b>1</b> 4	1		i	•		0.408			
Notes:	Notes:	Standard Cond	itions:	14.696 Psi	a, @ 60 deg. F.							
		Notes:						-				